

1           **PROCESS FOR UPGRADING FISCHER-TROPSCH PRODUCTS**  
2           **USING DEWAXING AND HYDROFINISHING**

4           **FIELD OF THE INVENTION**

6       The invention relates to a process for upgrading the hydrocarbons having an  
7       initial boiling point above about 120 degrees C recovered from a Fischer-  
8       Tropsch plant by bulk dewaxing a C<sub>5</sub> plus hydrocarbon Fischer-Tropsch  
9       syncrude followed by hydrofinishing and recovering diesel and lubricating  
10      base oil products having improved properties.

12           **BACKGROUND OF THE INVENTION**

14      The market for lubricating base oils of high paraffinicity is continuing to grow  
15      due to the high viscosity index, oxidation stability, and low volatility relative to  
16      viscosity of these oils. The products produced from the Fischer-Tropsch  
17      process (syncrude) contain a high proportion of wax which make them ideal  
18      candidates for processing into lubricating base stocks. Accordingly, the  
19      hydrocarbon products recovered from the Fischer-Tropsch process have been  
20      proposed as feedstocks for preparing high quality lubricating base oils. See,  
21      for example, US Patent 6,080,301 which describes a premium lubricating  
22      base oil having a high non-cyclic isoparaffin content prepared from Fischer-  
23      Tropsch waxes by hydroisomerization dewaxing and solvent dewaxing.

25      High quality diesel products also may be prepared from the syncrude  
26      recovered from the Fischer-Tropsch process. Fischer-Tropsch derived diesel  
27      typically has a very low sulfur content and an excellent cetane number.  
28      These qualities make Fischer-Tropsch derived diesel an excellent blending  
29      stock for upgrading lower quality petroleum-derived diesel.

31      In general, for the purposes of this disclosure, diesel is considered as having  
32      a upper boiling point of about 700 degrees F (370 degrees C) and an initial  
33      boiling point of about 300 degrees F (about 150 degrees C). Lubricating base  
34      oils typically will have an initial boiling point above about 600 degrees F

1 (about 315 degrees C). The syncrude fractions boiling in the range of diesel  
2 and lubricating base oils as they are initially recovered from the Fischer-  
3 Tropsch plant will usually contain a high proportion of waxy normal paraffins  
4 and unsaturated hydrocarbons, and therefore, these fractions require  
5 upgrading to meet commercial specifications for the finished products prior to  
6 their use either alone or as blending stock. During upgrading the various  
7 fractions are separated according to their respective boiling ranges. In the  
8 case of those fractions boiling in the ranges of lubricating base oils and diesel,  
9 upgrading steps generally are intended to lower the pour point to an  
10 acceptable temperature and to improve the oxidation and UV stability of the  
11 products. In order to improve the properties of these fractions, they are  
12 separated from the syncrude and separately dewaxed and hydrofinished.  
13 Applicants have discovered that contrary to conventional teaching, it is  
14 advantageous to bulk dewax and hydrofinish the entire C<sub>5</sub> plus syncrude  
15 fraction prior to separation of the various fractions.

16

17 Fischer-Tropsch wax refers to a high boiling fraction from the Fischer-Tropsch  
18 derived syncrude and is most often a solid at room temperature. For the  
19 purpose of this disclosure "Fischer-Tropsch wax" is contained in the higher  
20 boiling portion of the Fischer-Tropsch syncrude. Fischer-Tropsch wax  
21 contains at least 10 percent by weight of C<sub>20</sub> and higher hydrocarbonaceous  
22 compounds, preferably at least 40 percent by weight of C<sub>20</sub> and higher  
23 hydrocarbonaceous compounds, and most preferably at least 70 percent by  
24 weight of C<sub>20</sub> and higher hydrocarbonaceous compounds. Fischer-Tropsch  
25 wax is important for the present invention because this fraction will contain the  
26 heavier hydrocarbons which when sent to the catalytic dewaxing operation will  
27 be converted to high quality lubricating base oil and diesel.

28

29 C<sub>5</sub> plus syncrude refers to those fractions of the product from a Fischer-  
30 Tropsch plant which are normally a liquid or solid at ambient temperature.  
31 Usually hydrocarbons boiling above ambient temperature will include those  
32 hydrocarbons containing 5 or more carbon atoms in the molecule. However,  
33 one skilled in the art will recognize that other factors besides carbon number  
34 will affect the boiling ranges of the Fischer-Tropsch syncrude fractions, such

1 as, for example, the presence of unsaturated bonds, branching, and  
2 heteroatoms in the molecule. Therefore, some hydrocarbons may be present  
3 in this fraction which contain less than 5 carbon atoms. Products recovered  
4 from the Fischer-Tropsch synthesis which are normally in the gaseous phase  
5 at ambient temperature are referred to as C<sub>4</sub> minus product in this disclosure.  
6 LPG which is primarily a mixture of propane and butane is an example of a C<sub>4</sub>  
7 minus product.

8

9 Fractions boiling in the range of diesel may also be referred to as C<sub>10</sub> to C<sub>19</sub>  
10 hydrocarbons. Likewise, Fischer-Tropsch wax preferably is comprised  
11 predominantly of "C<sub>20</sub> plus product" which refers to a product comprising  
12 primarily hydrocarbons having more than 20 carbon atoms in the backbone of  
13 the molecule and having an initial boiling point at the upper end of the boiling  
14 range for diesel. It should be noted that the upper end of the boiling range for  
15 diesel and the lower end of the boiling range for Fischer-Tropsch wax have  
16 considerable overlap. The term "naphtha" when used in this disclosure refers  
17 to a liquid product having between about C<sub>5</sub> to about C<sub>9</sub> carbon atoms in the  
18 backbone and will have a boiling range generally below that of diesel but  
19 wherein the upper end of the boiling range will overlap that of the initial boiling  
20 point of diesel. C<sub>10</sub> plus hydrocarbons generally boil above the range of  
21 naphtha, i.e., the fractions boiling within the range of diesel and lubricating  
22 base oils or above about 150 degrees C. The precise cut-point selected for  
23 each of the products in carrying out the distillation operation will be  
24 determined by the product specifications and yields desired.

25

26 The dewaxing and hydrofinishing of C<sub>20</sub> plus hydrocarbons, including Fischer-  
27 Tropsch-derived syncrude is discussed in US Patent 5,135,638. The  
28 isomerization of lighter feeds boiling in the range of naphtha and diesel by  
29 contacting the feed with a catalyst containing a silicoaluminophosphate  
30 molecular sieve (SAPO) is discussed in US Patent 4,859,311.

31

32 As used in this disclosure the words "comprises" or "comprising" is intended  
33 as an open-ended transition meaning the inclusion of the named elements,  
34 but not necessarily excluding other unnamed elements. The phrase "consists

1 essentially of" or "consisting essentially of" is intended to mean the exclusion  
2 of other elements of any essential significance to the composition. The  
3 phrases "consisting of" or "consists of" are intended as a transition meaning  
4 the exclusion of all but the recited elements with the exception of only minor  
5 traces of impurities.

## SUMMARY OF THE INVENTION

9 Broadly, the present invention is directed to a process for producing low pour  
10 point hydrocarbon products having an initial boiling point above about 150  
11 degrees C from a Fischer-Tropsch plant which comprises (a) recovering a  
12 feedstock comprising C<sub>5</sub> plus syncrude from a Fischer-Tropsch plant; (b)  
13 dewaxing the C<sub>5</sub> plus syncrude feedstock in a catalytic dewaxing zone by  
14 contacting the C<sub>5</sub> plus syncrude feedstock with a dewaxing catalyst under  
15 dewaxing conditions, whereby a C<sub>5</sub> plus intermediate is produced having a  
16 lowered pour point relative to the C<sub>5</sub> plus syncrude feedstock; (c)  
17 hydrofinishing the C<sub>5</sub> plus intermediate in a hydrofinishing zone under  
18 hydrofinishing conditions, whereby a UV stabilized C<sub>5</sub> plus product is  
19 produced; and (d) separately collecting from the UV stabilized C<sub>5</sub> plus product  
20 a low pour point product having an initial boiling point above about 150  
21 degrees C. The low pour point product of step (d) will generally consist of  
22 diesel and lubricating base oil products, although depending on how the  
23 operation is run the proportional yields of the products may vary over a  
24 considerable range.

25  
26 In one embodiment of the invention, the preferred dewaxing catalyst is a  
27 hydroisomerization catalyst, such as, for example, a catalyst comprising a  
28 silicoaluminophosphate molecular sieve, commonly referred to as a SAPO, in  
29 combination with a hydrogenation component comprising an active metal.  
30 The SAPO is preferably an intermediate pore SAPO, such as, for example,  
31 SAPO-11, SAPO-31, and SAPO-41, with SAPO-11 being especially preferred.  
32 Other aluminophosphates besides SAPO's can be used (broad category of  
33 "non-zeolitic molecular sieves") and are taught in US Patent 5,135,638, col.  
34 10, lines 24-31. A more complete description is in US Patent 5,883,837, col.

1       8, lines 5-17. Accordingly, this embodiment of the invention may be described  
2       as a process for producing low pour point syncrude products having an initial  
3       boiling point above about 150 degrees C from a Fischer-Tropsch plant which  
4       comprises (a) recovering a feedstock comprising C<sub>5</sub> plus syncrude from a  
5       Fischer-Tropsch plant; (b) dewaxing the C<sub>5</sub> plus syncrude feedstock in a  
6       hydroisomerization zone by contacting the C<sub>5</sub> plus syncrude feedstock with a  
7       hydroisomerization catalyst under hydroisomerization conditions, whereby an  
8       isomerized C<sub>5</sub> plus intermediate is produced having a lowered pour point  
9       relative to the C<sub>5</sub> plus syncrude feedstock; (c) hydrofinishing the isomerized  
10      C<sub>5</sub> plus intermediate in a hydrofinishing zone under hydrofinishing conditions,  
11      whereby a UV stabilized C<sub>5</sub> plus product is produced; and (d) separately  
12      collecting from the UV stabilized hydrocarbon product a low pour point diesel  
13      product and a lubricating base oil product. Hydroisomerization catalysts  
14      comprising SAPO-11 in association with a hydrogenation component are  
15      particularly preferred. The hydrogenation component usually comprises an  
16      active metal, such as molybdenum, nickel, vanadium, cobalt, tungsten, zinc,  
17      platinum, and palladium. The metals platinum and palladium are especially  
18      preferred as the active metals. Those SAPOs in which the metals have been  
19      added by means of non-aqueous addition as taught in US Patent 5,939,349  
20      are especially preferred.

21  
22      Ultra high VI base oil products, i.e., products having a VI of greater than 140,  
23      can be obtained by using a dewaxing catalyst comprising a intermediate pore  
24      zeolite, usually in association with an active metal having hydrogenation  
25      activity. Suitable intermediate pore size zeolites include SSZ-32, ZSM-22,  
26      ZSM-23, ZSM-35, and ZSM-48. The zeolites SSZ-32, ZSM-22, and ZSM-23  
27      are particularly preferred. The active metal component is as already  
28      described above. This embodiment of the present invention may be  
29      described as a process for producing an ultra high VI, low pour point  
30      lubricating base oil product from a Fischer-Tropsch plant which comprises (a)  
31      recovering a feedstock comprising C<sub>5</sub> plus syncrude from a Fischer-Tropsch  
32      plant; (b) dewaxing the C<sub>5</sub> plus syncrude feedstock in a catalytic  
33      hydrotreating zone by contacting the C<sub>5</sub> plus hydrocarbon feedstock with  
34      hydroisomerization dewaxing catalyst comprising an intermediate pore size

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1 zeolite and at least one metal having hydrogenation activity, said dewaxing  
2 being carried out under hydrodewaxing conditions selected to produce an C<sub>5</sub>  
3 plus intermediate having a lowered pour point relative to the C<sub>5</sub> plus syncrude  
4 feedstock; (c) hydrofinishing the C<sub>5</sub> plus intermediate in a hydrofinishing zone  
5 under hydrofinishing conditions, whereby a UV stabilized C<sub>5</sub> plus product is  
6 produced; and (d) separately collecting from the UV stabilized C<sub>5</sub> plus product  
7 an ultra high VI, low pour point lubricating base oil product. The term  
8 "intermediate pore size" when referring to either a zeolite or a SAPO in this  
9 disclosure means an inorganic molecular sieve having an effective pore  
10 aperture in the range of from about 5.3 to about 6.5 Angstrom when the  
11 porous inorganic oxide is in the calcined form. The most preferred zeolites for  
12 producing ultra high VI products are somewhat more restricted having an  
13 effective pore aperture of between about 5.0 to about 5.5 Angstrom.

14

15 In conventional processes for upgrading Fischer-Tropsch product into diesel  
16 and lubricating base oils, the various fractions usually are separated prior to  
17 upgrading. During dewaxing of that Fisher-Tropsch fraction boiling above  
18 about 315 degrees C some wax cracking will occur which will yield lower  
19 molecular products such as diesel, naphtha, and C<sub>5</sub> minus hydrocarbons.

20 When one of the preferred SAPO catalysts having high diesel selectivity, such  
21 as SAPO-11, is used to dewax the fraction boiling in the lubricating base oil  
22 range, diesel is preferentially produced as opposed to less valuable products  
23 such as naphtha and C<sub>5</sub> minus hydrocarbons. In a conventional operation, a  
24 second separation will generally be necessary following the dewaxing  
25 operation, since considerable additional high value diesel is produced. In the  
26 present invention only a single separation step is necessary to collect all of  
27 the diesel which results in a significant cost saving. In addition, with the  
28 present invention, the diesel fraction recovered from the dewaxing operation  
29 will have an especially low pour point, preferably below about -20 degrees C  
30 and more preferably below about -30 degrees C. The low pour point of the  
31 diesel allows the end point to be extended which also increases the yield of  
32 diesel in the overall product slate.

33

34

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1                   BRIEF DESCRIPTION OF THE DRAWING

2

3     The figure is a schematic diagram of one embodiment of the invention.

4

5                   DETAILED DESCRIPTION OF THE INVENTION

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7     The present invention will be more clearly illustrated by reference to the  
8     figure. Synthesis gas or syngas comprised primarily of carbon monoxide and  
9     hydrogen is sent to the Fischer-Tropsch reactor 4 via inlet 2. The Fischer-  
10    Tropsch syncrude comprised primarily of C<sub>5</sub> plus hydrocarbons is carried by  
11    line 6 to the dewaxing unit 8 where the pour point of the syncrude, especially  
12    of those fractions of the syncrude boiling in the range of diesel and lubricating  
13    base oils is lowered. The C<sub>5</sub> plus intermediate that is collected from the  
14    dewaxing unit is carried by line 10 to the hydrofinishing unit 12 where any  
15    remaining unsaturated carbon-to-carbon double bonds are saturated and the  
16    UV stability of the hydrocarbons is improved. The UV stabilized C<sub>5</sub> plus  
17    product is collected by line 14 and sent to the distillation column 16 where the  
18    various fractions are separated. In the figure the products shown as being  
19    separately collected are C<sub>4</sub> minus product 18, naphtha 20, diesel 22, and  
20    lubricating base oil 24, respectively.

21

22                   FISCHER-TROPSCH SYNTHESIS

23

24     In the Fischer-Tropsch synthesis process, liquid and gaseous hydrocarbons  
25     are formed by contacting a synthesis gas (syngas) comprising a mixture of  
26     hydrogen and carbon monoxide with a Fischer-Tropsch catalyst under  
27     suitable temperature and pressure reactive conditions. The Fischer-Tropsch  
28     reaction is typically conducted at temperatures of from about 300 F to about  
29     700 degrees F (about 150 degrees C to about 370 degrees C) preferably from  
30     about 400 degrees F to about 550 degrees F (204 degrees C to 228 degrees  
31     C); pressures of from about 10 to about 600 psia, (0.7 bar to 41 bars)  
32     preferably 30 psia to 300 psia, (2 bars to 21 bars) and catalyst space  
33     velocities of from about 100 cc/g/hr to about 10,000 cc/g/hr., preferably 300 to  
34     3,000 cc/g/hr.

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2 The products may range from C<sub>1</sub> to C<sub>200</sub> plus hydrocarbons with a majority in  
3 the C<sub>5</sub> to C<sub>100</sub> plus range. The reaction can be conducted in a variety of  
4 reactor types, for example, fixed bed reactors containing one or more catalyst  
5 beds, slurry reactors, fluidized bed reactors, or a combination of different type  
6 reactors. Such reaction processes and reactors are well known and  
7 documented in the literature. Slurry Fischer-Tropsch processes, which is a  
8 preferred process in the practice of the present invention, utilize superior heat  
9 (and mass) transfer characteristics for the strongly exothermic synthesis  
10 reaction and are able to produce relatively high molecular weight, paraffinic  
11 hydrocarbons when using a cobalt catalyst. In a slurry process, a syngas  
12 comprising a mixture of hydrogen and carbon monoxide is bubbled up as a  
13 third phase through a slurry in a reactor which comprises a particulate  
14 Fischer-Tropsch type hydrocarbon synthesis catalyst dispersed and  
15 suspended in a slurry liquid comprising hydrocarbon products of the synthesis  
16 reaction which are liquid at the reaction conditions. The mole ratio of the  
17 hydrogen to the carbon monoxide may broadly range from about 0.5 to about  
18 4, but is more typically within the range of from about 0.7 to about 2.75 and  
19 preferably from about 0.7 to about 2.5. A particularly preferred Fischer-  
20 Tropsch process is taught in EP0609079, which is completely incorporated  
21 herein by reference for all purposes.

22 Suitable Fischer-Tropsch catalysts comprise one or more Group VIII catalytic  
23 metals such as Fe, Ni, Co, Ru and Re, with cobalt being preferred.  
24 Additionally, a suitable catalyst may contain a promoter. Thus, a preferred  
25 Fischer-Tropsch catalyst comprises effective amounts of cobalt and one or  
26 more of Re, Ru, Pt, Fe, Ni, Th, Zr, Hf, U, Mg and La on a suitable inorganic  
27 support material, preferably one which comprises one or more refractory  
28 metal oxides. In general, the amount of cobalt present in the catalyst is  
29 between about 1 and about 50 weight percent of the total catalyst  
30 composition. The catalysts can also contain basic oxide promoters such as  
31 ThO<sub>2</sub>, La<sub>2</sub>O<sub>3</sub>, MgO, and TiO<sub>2</sub>, promoters such as ZrO<sub>2</sub>, noble metals (Pt, Pd,  
32 Ru, Rh, Os, Ir), coinage metals (Cu, Ag, Au), and other transition metals such  
33 as Fe, Mn, Ni, and Re. Suitable support materials include alumina, silica,

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1 magnesia and titania or mixtures thereof. Preferred supports for cobalt  
2 containing catalysts comprise titania. Useful catalysts and their preparation  
3 are known and illustrated in U.S. Patent 4,568,663, which is intended to be  
4 illustrative but non-limiting relative to catalyst selection.

5

6 CATALYTIC DEWAXING

7

8 Although not shown in the figure, it may be desirable to include a pretreatment  
9 step for the syncrude prior to its introduction into the dewaxing unit, since raw  
10 syncrude typically contains a number of contaminants which act as catalyst  
11 poisons, most notably nitrogen and oxygen compounds. Both the nitrogen  
12 and oxygen compounds may be removed by hydrotreating. Preferably the  
13 nitrogen in the feed stock to the dewaxing reactor should be below 50 ppm  
14 and more preferably below 10 ppm. Alternatively, the alcohols may be  
15 dehydrated to remove water prior to dewaxing. Other methods for removing  
16 contaminants include adsorption and extraction.

17

18 Catalytic dewaxing consists of three main classes, conventional  
19 hydrodewaxing, complete hydroisomerization dewaxing, and partial  
20 hydroisomerization dewaxing. All three classes involve passing a mixture of a  
21 waxy hydrocarbon stream and hydrogen over a catalyst that contains an  
22 acidic component to convert the normal and slightly branched iso-paraffins in  
23 the feed to other non-waxy species, such as lubricating oil base stocks with  
24 acceptable pour points. Typical conditions for all classes involve  
25 temperatures from about 400 degrees F to about 800 degrees F (200 degrees  
26 C to 425 degrees C), pressures from about 200 psig to 3000 psig, and space  
27 velocities from about 0.2 to 5 hr-1. The method selected for dewaxing a feed  
28 typically depends on the product quality, and the wax content of the feed, with  
29 conventional hydrodewaxing often preferred for low wax content feeds. The  
30 method for dewaxing can be effected by the choice of the catalyst. The  
31 general subject is reviewed by Avilino Sequeira, in *Lubricant Base Stock and*  
32 *Wax Processing*, Marcel Dekker, Inc. pages 194-223. The determination  
33 between conventional hydrodewaxing, complete hydroisomerization

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1 dewaxing, and partial hydroisomerization dewaxing can be made by using the  
2 n-hexadecane isomerization test as described in U.S. Patent No. 5,282,958.  
3 When measured at 96 percent, n-hexadecane conversion using conventional  
4 hydrodewaxing catalysts will exhibit a selectivity to isomerized hexadecanes  
5 of less than 10 percent, partial hydroisomerization dewaxing catalysts will  
6 exhibit a selectivity to isomerized hexadecanes of greater than 10 percent to  
7 less than 40 percent, and complete hydroisomerization dewaxing catalysts will  
8 exhibit a selectivity to isomerized hexadecanes of greater than or equal to 40  
9 percent, preferably greater than 60 percent, and most preferably greater than  
10 80 percent.

11

12 In conventional hydrodewaxing, the pour point is lowered by selectively  
13 cracking the wax molecules mostly to smaller paraffins using a conventional  
14 hydrodewaxing catalyst, such as, for example ZSM-5. Metals may be added  
15 to the catalyst, primarily to reduce fouling. In the present invention  
16 conventional hydrodewaxing may be used to increase the yield of lower  
17 molecular weight products in the final product slate by cracking the Fischer-  
18 Tropsch wax molecules.

19

20 Complete hydroisomerization dewaxing typically achieves high conversion  
21 levels of wax by isomerization to non-waxy iso-paraffins while at the same  
22 time minimizing the conversion by cracking. Since wax conversion can be  
23 complete, or at least very high, this process typically does not need to be  
24 combined with additional dewaxing processes to produce a lubricating oil  
25 base stock with an acceptable pour point. Complete hydroisomerization  
26 dewaxing uses a dual-functional catalyst consisting of an acidic component  
27 and an active metal component having hydrogenation activity. Both  
28 components are required to conduct the isomerization reaction. The acidic  
29 component of the catalysts used in complete hydroisomerization preferably  
30 include an intermediate pore SAPO, such as SAPO-11, SAPO-31, and SAPO-  
31 41, with SAPO-11 being particularly preferred. Intermediate pore zeolites,  
32 such as ZSM-22, ZSM-23, SSZ-32, ZSM-35, and ZSM-48, also may be used  
33 in carrying out complete hydroisomerization dewaxing. Typical active metals  
34 include molybdenum, nickel, vanadium, cobalt, tungsten, zinc, platinum, and

1 palladium. The metals platinum and palladium are especially preferred as the  
2 active metals, with platinum most commonly used.

3

4 In partial hydroisomerization dewaxing a portion of the wax is isomerized to  
5 iso-paraffins using catalysts that can isomerize paraffins selectively, but only if  
6 the conversion of wax is kept to relatively low values (typically below 50  
7 percent). At higher conversions, wax conversion by cracking becomes  
8 significant, and yield losses of lubricating base stock becomes uneconomical.  
9 Like complete hydroisomerization dewaxing, the catalysts used in partial  
10 hydroisomerization dewaxing include both an acidic component and a  
11 hydrogenation component. The acidic catalyst components useful for partial  
12 hydroisomerization dewaxing include amorphous silica aluminas, fluorided  
13 alumina, and 12-ring zeolites (such as Beta, Y zeolite, L zeolite). The  
14 hydrogenation component of the catalyst is the same as already discussed  
15 with complete hydroisomerization dewaxing. Because the wax conversion is  
16 incomplete, partial hydroisomerization dewaxing must be supplemented with  
17 an additional dewaxing technique, typically solvent dewaxing, complete  
18 hydroisomerization dewaxing, or conventional hydrodewaxing in order to  
19 produce a lubricating base stock with an acceptable pour point (below about  
20 +10 degrees F or -12 degrees C).

21

22 The present invention may also be used to prepare ultra-high VI lubricating  
23 base oils. Catalysts containing SAPO's, such as SAPO-11, have been used  
24 to produce ultra-high VI lubricating base oils. However, an intermediate pore  
25 zeolite with one-dimensional pores, such as, for example, SSZ-32, ZSM-23,  
26 and ZSM-22 also may be used in carrying out the present invention if a  
27 lubricating base oil product having ultra high VI is desired. The term one-  
28 dimensional pores, also referred to as 1-D pores, is fully explained in US  
29 Patent 5,135,638, column 6, at lines 31-41. Briefly, the term refers to a zeolite  
30 in which the intracrystalline channels are parallel and are not interconnected.  
31 The production of ultra high VI lubricating base oil in this embodiment is  
32 particularly surprising because with conventional petroleum-derived feeds,  
33 catalysts containing SAPOs will usually produce a higher VI product than

those catalysts containing a zeolite. Preferably the intermediate pore zeolite is used in association with an active metal having hydrogenation activity.

3

4 In preparing those catalysts containing a non-zeolitic molecular sieve and  
5 having an hydrogenation component for use in the present invention, it is  
6 usually preferred that the metal be deposited on the catalyst using a non-  
7 aqueous method. Catalysts, particularly catalysts containing SAPO's, on  
8 which the metal has been deposited using a non-aqueous method have  
9 shown greater selectivity and activity than those catalysts which have used an  
10 aqueous method to deposit the active metal. The non-aqueous deposition of  
11 active metals on non-zeolitic molecular sieves is taught in US Patent  
12 5,939,349. In general, the process involves dissolving a compound of the  
13 active metal in a non-aqueous, non-reactive solvent and depositing it on the  
14 molecular sieve by ion exchange or impregnation.

15

## HYDROFINISHING

17

18 Hydrofinishing operations are intended to improve the UV stability and color of  
19 the products. It is believed this is accomplished by saturating the double  
20 bonds present in the hydrocarbon molecule, including those found in  
21 aromatics, especially polycyclic aromatics. In the process of the present  
22 invention, the C<sub>5</sub> plus intermediate recovered from the dewaxing operation is  
23 sent to a hydrofinisher. A general description of the hydrofinishing process  
24 may be found in US Patents 3,852,207 and 4,673,487. As used in this  
25 disclosure the term UV stability refers to the stability of the lubricating base oil  
26 or other products when exposed to ultraviolet light and oxygen. Instability is  
27 indicated when a visible precipitate forms or darker color develops upon  
28 exposure to ultraviolet light and air which results in a cloudiness or floc in the  
29 product. Lubricating base oils and diesel products prepared by the process of  
30 the present invention will require UV stabilization before they are suitable for  
31 use in the manufacture of commercial lubricating oils and marketable diesels.

32

33 Typically, the total pressure in the hydrofinishing zone will be between about  
34 200 psig and about 3000 psig, with pressures in the range of about 500 psig

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1 and about 2000 psig being preferred. Temperature ranges in the  
2 hydrofinishing zone are usually in the range of from about 300 degrees F (150  
3 degrees C) to about 700 degrees F (370 degrees C), with temperatures of  
4 from about 400 degrees F (205 degrees C) to about 500 degrees F (260  
5 degrees C) being preferred. The LHSV is usually within the range of from  
6 about 0.2 to about 2.0, preferably 0.2 to 1.5 and most preferably from about  
7 0.7 to 1.0. Hydrogen is usually supplied to the hydrofinishing zone at a rate of  
8 from about 1000 to about 10,000 SCF per barrel of feed. Typically the  
9 hydrogen is fed at a rate of about 3000 SCF per barrel of feed. The  
10 hydrofinishing step may be integrated into the same gas system as the  
11 dewaxing step.

12

13 Suitable hydrofinishing catalysts typically contain a Group VIII metal  
14 component together with an oxide support. Metals or compounds of the  
15 following metals are useful in hydrofinishing catalysts include nickel,  
16 ruthenium, rhodium, iridium, palladium, platinum, and osmium. Preferably the  
17 metal or metals will be platinum, palladium or mixtures of platinum and  
18 palladium. The refractory oxide support usually consists of alumina, silica,  
19 silica-alumina, silica-alumina-zirconia, and the like. The catalyst may  
20 optionally contain a zeolite component. Typical hydrofinishing catalysts are  
21 disclosed in US Patents 3,852,207; 4,157,294; and 4,673,487.

22

In carrying out the invention, the cut-point between those Fischer-Tropsch fractions boiling in the range of diesel and lubricating base oil may be adjusted to either increase the yield of diesel or the yield of lubricating base oil. For example by extending the cut-point for diesel, it is possible to not only maximize the yield of diesel but still also produce a diesel product having a very low cloud point and pour point. At the same time, the volatility of the lubricating base oil cut is minimized which is major commercial selling point for lubricants.

31

When a SAPO, such as SAPO-11, is used as the hydroisomerization catalyst in the dewaxing operation, diesel is the primary product of the wax-cracking. Consequently, the actual yield for the less valuable naphtha and C<sub>4</sub> minus gas

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1 is minimized. The cut-point between the diesel product and the lubricating  
2 base oil product during fractionation may also be adjusted to decrease or  
3 increase the amount of diesel present in the final product slate. For example,  
4 the cut-point selected could be as low as 600 degrees F (515 degrees C).  
5 This would increase the amount of lubricating base oil recovered at the  
6 expense of diesel. Likewise, the cut-point could be selected as high as 700  
7 degrees F (370 degrees C) or more. This would increase the amount of  
8 diesel recovered at the expense of the yield of lubricating base oil. However,  
9 in this later case the diesel recovered will have an especially low pour point  
10 and the lubricating base oil will very low volatility.

11

12 Finally as already noted, the present process of the present invention requires  
13 only a single fractionation operation instead of the two fractionation steps  
14 which would be necessary using a conventional processing scheme.  
15 Accordingly, the present invention results in a significant cost savings over  
16 conventional operations.

17

18 The following example is intended to further illustrate a specific embodiment  
19 of the invention without being interpreted as a limitation thereon.

20

21 EXAMPLE

22

23 A Fischer-Tropsch derived feedstock having the specifications shown in  
24 Table 1 was dewaxed using a hydrocracking catalyst and a  
25 hydroisomerization catalyst.

1

Table 1

2

API Gravity	49.0
Nitrogen, ppm	17
Sulfur, ppm	11
Oxygen, wt%	1.12
Simulated Distillation, TBP (°F)	
1/5 wt%	152/236
10/30	287/422
50	564
70/90	718/965
95/99	1062/1275

3

- 4 A commercially available nickel-Tungsten silica/alumina diesel hydrocracking  
5 catalyst was compared to a hydroisomerization catalyst containing 25 weight  
6 percent SAPO-11 on alumina with platinum present as the hydrogenation  
7 component. The feed was dewaxed at a total pressure of 1000 psig, a liquid  
8 hourly space velocity of 1.0, and a once through gas rate of 10,000 SCF  
9 H<sub>2</sub>/bbl. The products recovered from the dewaxing operation were not  
10 hydrofinished and had the properties shown in Table 2.

1

Table 2

2

	Commercial Catalyst	Pt/SAPO-11
Catalyst Temp, F	672	736
Yields, wt%		
C4-	1.0	1.6
Naphtha (C5-300°F)	13.7	17.5
Diesel (300-700°F)	69.2	64.0
Base Oil (700°F+)	15.2	16.0
Diesel Properties		
Cloud Pt, °C	-9	-35
Vis@40°C, cSt	2.1	2.1
Base Oil Properties		
Pour Pt, °C	+13	-12
Vis@100°C, cSt	3.8	4.4
VI	133	158

3

4 Table 2 illustrates that the Fischer-Tropsch product may be bulk dewaxed and  
5 successfully produce satisfactory yields of diesel and lubricating base oil  
6 having excellent properties. The diesel recovered using the Pt/SAPO catalyst  
7 had a significantly lower cloud point than the diesel recovered using the  
8 conventional catalyst. When the lubricating base oils derived from the  
9 dewaxing operations are compared, it should be noted that the product  
10 derived using the Pt/SAPO catalyst had a significantly lower pour point and  
11 higher viscosity at 100 degrees C. In addition, the lubricating base oil product  
12 had a VI of 158 which is well in excess of that required to qualify as an ultra-  
13 high VI product.